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Influence of the quality of canal obturation and prosthetic restoration on the peri-apical region

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Abstract

The periapical inflammatory lesion of endodontic origin (LIPOE) is a very common condition and constitutes both a diagnostic and a therapeutic challenge in dentistry.

The present study aims to describe the frequency of LIPOE after endodontic treatment consecutive to the quality of root canal fillings and prosthetic restorations of abutment teeth and to identify the qualities of root canal fillings and prosthetic restorations associated with the occurrence of LIPOE.

This is a prospective, descriptive and cross-sectional study carried out from March 2019 to August 2022. One hundred and eighty patients wearing Joint Prosthesis for at least 2 years with endodontically treated abutment teeth have been recruited; the evaluation of the quality of prosthetic restoration was established according to the criteria of Hickel R while the quality of the root canal filling was judged according to the criteria of Schaeffer MA.

The frequency of LIPOE on the abutment teeth was 59.4%. The results highlighted that inadequate quality of prosthetic restoration and root canal filling is associated with the occurrence of LIPOE with a highly significant difference ($p < 0.000$)

In order, to reduce the prevalence of LIPOE and mitigate its effects, it is essential to follow the rules of the art when considering mechanical and biological imperatives during endodontic treatment, as well as good training in prosthetic restoration.

Keywords: Apical periodontitis; Fixed prosthesis; Endodontic treatment; Root canal fillings; Prosthetic restorations

1 Introduction

The endodontically treated tooth must regain its form, function and aesthetics and the quality of the crown restoration will have a direct impact on the survival and success of the endodontically treated tooth [1].

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The use of one or more teeth as abutment in fixed prosthesis requires a multidimensional approach between endodontics and prosthodontics. The quality of the root canal filling is the first key to the successful of the fixed prosthetic restoration of an abutment tooth requiring endodontic treatment.

However, endodontic success rates still appear to be well below 100%. The persistence and occurrence of a peri-apical inflammatory lesion are generally indicative of root canal treatment failure [2].

The peri-apical inflammatory lesion of endodontic origin (LIPOE) also called apical periodontitis is a localized inflammatory process of the periradicular periodontium (most often peri-apical) in response to an aggression of endodontic origin (Lasfargues *and al.* 2010) [3].

A recent review reported that the worldwide prevalence of individuals with at least apical periodontitis was 52% and it was more common in endodontically filled teeth (39%) than unfilled teeth (5%) [4]. The prevalence and frequencies of LIPOE range from 27% in Finland to 83% in Jordan [5, 6]. Studies based on a nationally representative survey in Finland showed that for teeth with LIPOE, the technical quality of root fillings was judged to be insufficient for 53% of all filled teeth [7]. Thus, the presence of LIPOE can occur as a result of improper treatment of the root canal, insufficient cleaning or defective closure of the root canal system.

However, the quality of the coronal restoration can also affect the periapical condition of endodontically treated teeth due to coronal leakage [8]. But the risk was about three times higher depending on the quality of the root canal filling than the quality of the prosthetic restoration according to the study in Turkey in 2021. It was reported in this study that the abutment teeth of an endodontically treated bridge tended to be 2.44 times more at risk of apical periodontitis [9].

In addition, abutment teeth with endodontic treatments developed apical periodontitis more frequently than abutment teeth that were kept vital according to the study done in Romania in 2019 [10]. In 2018, according to a study in Thailand, teeth with both root filling and inadequate coronal restoration had the highest prevalence of LIPOE at 73.6% [11].

Faced with these situations, it is obvious that iatrogenic causes are among the factors influencing the occurrence of LIPOE. According to a study carried out in Saudi Arabia, endodontic treatment may be underestimated by practitioners, in the knowledge that the condition of the root canal filling is not observed clinically, and that the tooth will later be crowned by a fixed prosthesis which functions as a barrier to reinfection of the root canal system after root canal treatment [12]. For this purpose, emphasis must be on the quality of the practitioners' work.

This study was carried out to assess the quality of root canal fillings and prosthetic restorations of abutment teeth and to answer the following research question: "Are we doing the right thing?" » Therapeutic errors or failures on the part of practitioners can have harmful consequences on the periapical state of the tooth.

The aims of this study are to

- Describe the frequency of LIPOE after endodontic treatment resulting from the quality of root canal fillings and prosthetic restorations of abutment teeth;
- Identify the qualities of root canal fillings associated with the occurrence of LIPOE;
- Déterminer the qualities of prosthetic restorations related to the occurrence of LIPOE.

2 Material and methods

This is a prospective, descriptive and cross-sectional study carried out from March 2019 to August 2022 in a dental care center "Kintana" located in Mahajanga. The study population is made up of 180 patients with joint prostheses, aged over 25 years, who came for consultation at the health center. Exhaustive sampling was chosen to constitute the sample. Patients with Joint Prostheses for at least 2 years who's endodontically treated abutment teeth were included in this study.

Mentally handicapped and uncooperative patients were excluded from the study.

The following items and information have been recorded:

- Social characteristics (gender, age)

- The characteristics of the abutment teeth (monorooted, multirooted)
- Types of prostheses (single, plural)
- The condition of the prosthetic restorations on the presence of overhangs, non-respect of the contact point, the non-hermetic cervical margin
- The radiographic aspects of the abutment teeth on the presence of caries, short post, overflowing or insufficient root canal filling, the state of the apex to look for the presence of a radiolucent image as well as the discontinuity of the lamina dura and ligament space suggestive of LIPOE [13]. The retro-alveolar radiograph was used to assess the condition of the abutment teeth.

Based on the results of these items, the qualities of prosthetic restorations and root canal fillings were classified as one of the following:

- For prosthetic restoration: the Hickel R criterion [14] was used to evaluate the prosthetic restoration
 - Adequate if no overhangs, contact point respected, cervical margin sealed, no caries on radiography
 - Inadequate if presence of overhangs, non-respect of the contact point, non-hermetic cervical limit, presence of caries and short post on x-ray
- For the quality of the root canal obturation: it was judged according to the evaluation criteria of Schaeffer MA [15]
 - Adequate if optimal density, airtightness of the canal filling and respect of the apical limit
 - Inadequate if over flowing or insufficient root canal filling

A pre-established, tested and validated anonymous questionnaire was developed and a meticulous clinical and radiographic examination was carried out to collect information.

Free and informed consent was declared on the part of the patients after having clearly explained to them the objectives of the study. Data were analyzed with SPSS 20.0 software. Then the association between the occurrence of LIPOE and the qualities of prosthetic restorations and the qualities of root canal fillings was verified using the Chi-square test. The results were considered significant for a value of $p < 0.05$.

3 Results

Table 1 Social characteristics of the sample

Social characteristics	Effective (n)	Proportion (%)
Gender		
Male	75	41.7
Feminine	105	58.3
Age (in years)		
25 to 34	31	17.2
35 to 44	76	42.2
45 to 54	35	19.4
55 to 64	22	12.2
≥ 65	16	8.9
Total	180	100

Table 2 Characteristics of abutment teeth and types of prostheses

Samples	Effective (n)	Proportion (%)
Abutment teeth features		
Monorooted	114	63.3

Multirrooted	66	36.7
Types of prostheses		
Unitary	125	69.4
Plural	55	30.6
Total	180	100

Table 3 Distribution of the sample according to the quality of the prosthetic restoration and qualities of the root canal filling

Samples	effective (n)	Proportion (%)
Quality of prosthetic restoration		
Adequate	91	50.6
Inadequate	89	49.4
Root canal filling qualities		
Adequate	89	49.4
Inadequate	91	50.6
Total	180	100

Table 4 Distribution of the sample according to the root canal filling materials

Root canal filling materials	effective (n)	Proportion (%)
ZOE	57	31.7
Gutta percha	50	27.8
ZOE and Gutta percha	73	4.6
Total	180	100

ZOE= Zinc Oxyde Eugenol

Table 5 Clinical characteristics of the prosthetic restoration and radiographic aspects of the abutment teeth

Characteristic	Effective (n=180)	Proportion (%)
Prosthetic restoration		
Normal	64	35.6
overhang	32	17.8
Non-respect of point of contact	17	9.4
Non-hermetic cervical limit	67	37.2
Radiographic aspects		
Normal	28	15.6
Short tenon	40	22.2
Presence of caries	22	12.2
Overflowing root canal filling	30	16.7
Incomplete root canal filling	60	33.3

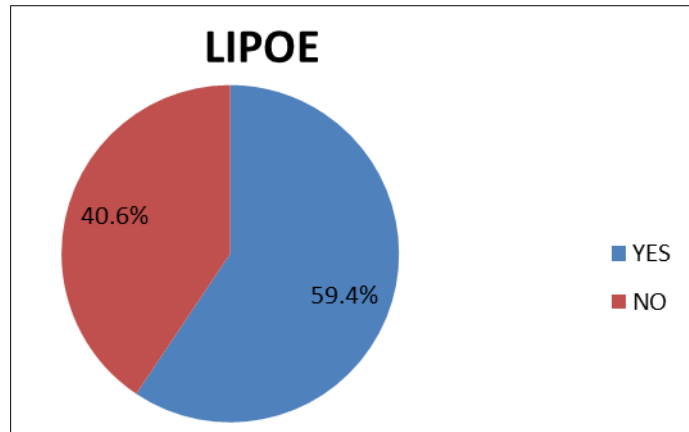


Figure 1 Distribution of the sample according to the frequency of LIPOE

Table 6 Distribution of the sample according to the frequency of LIPOE and the quality of the prosthetic restoration and qualities of the root canal filling

Prosthetic restoration quality	LIPOE						p
	Yes		No		Total		
	not	%	not	%	N=180	%	
							0.000
Adequate	34	37.4	57	62.6	91	100	
Inadequate	73	82	16	18	89	100	
Root canal filling qualities							0.000
Adequate	20	22.5	69	77.5	89	100	
Inadequate	87	95.6	04	4.4	91	100	

Table 7 Distribution of the sample according to the frequency of LIPOE and the factors influencing the quality of prosthetic restoration and quality of root canal filling

Inadequate prosthetic restoration	LIPOE						p
	Yes		No		Total		
	n	%	n	%	N	%	
Short tenon	31	77.5	09	22.5	40	100	0.008
Overhang	30	93.8	02	6.2	32	100	0.000
Caries on abutment tooth	21	95.5	01	4.5	22	100	0.000
Non-respect of point of contact	12	70.6	05	29.4	17	100	
Non-hermetic cervical limit	61	91	06	9.0	67	100	0.000
Root canal filling quality							
Overflowing root canal filling	28	93.3	02	6.7	30	100	0.000
Incomplete root canal filling	58	96.7	02	3.3	60	100	0.000

4 Discussion

The present study is a prospective cross-sectional study whose aim was to assess the quality of root canal fillings and prosthetic restorations of endodontically treated abutment teeth.

Decades ago, periapical radiography was the only imaging method available to diagnose Apical Periodontitis (AP) [16]. More recently, “Cone Beam Computed Tomography” CBCT has proved to be a more sensitive way to detect changes in bone structure density and the presence of periapical rarefactions. It also allows three-dimensional visualization of the location of any lesions [17]. In the present study, for lack of this required means, the peri-apical radiography was opted for the evaluation of the peri-apical state, and consequently this study was recognized as limited since the evaluations were based on two-dimensional radiographs [18]. However, in an attempt to overcome the limitations of radiographic assessment, a careful clinical examination was carried out to evaluate the quality of coronal restorations. It is recognized that there are limitations to the use of radiographic examination alone when evaluating the quality of coronary restorations [19]. Leaking occlusal margins and cracks/perforations in restorations may not be observed on radiographs.

Among the samples studied, the female gender predominates at 58.3% with a sex ratio of 0.7. This predominance means that the proportion of female joint prosthesis wearers is high compared with men. This result is similar to the study by Gheorghe AG *and al*, in 2019 [10]. According to age, the 35-44 age group accounts for 42.2% of the patients studied (table 1). Single prosthesis wearers make up the majority of our sample (69.4%). (Table 2)

4.1 Clinical and radiographic assessment of abutment teeth

According to the clinical evaluation of prosthetic restoration quality, it was considered adequate in the absence of overjet, with respect for the contact point and hermetic cervical limit. In this study, the prosthetic restoration was qualified as adequate on 91 teeth (50.6%), versus 89 teeth (49.4%) (Table 3). This last proportion is high compared with that of a similar study carried out in several French hospital dental departments [20], which found an inadequate prosthetic restoration in 30.4% of cases. This difference could be explained by the quality of the instruments used, with the practitioner’s experience showing the need to emphasize good training in prosthetic restoration. Similarly, the most frequent cause was the presence of a non-hermetic cervical limit in 37.2% of cases (table 5), in particular the presence of a hiatus between the dental walls and the restorative material. Reflecting an inadequate seal, the reason for which could be the quality and type of prosthetic restorative materials.

The quality of the root canal filling is a crucial factor for the success of endodontic treatment. In radiographic assessment, a root canal filling is considered adequate if the density is optimal, hermetic and respects the apical limit. In the present study, 89 teeth or 49.4% presented an adequate root canal filling against 91 teeth or 50.6% (table 3) and the latter is high compared with the result of the study carried out by Conert *and al* in 2018, 34.8% of root canal fillings were inadequate [21]. This difference could be explained by the type of root canal filling materials used; in this study, 31.7% of abutment teeth showed a root canal filling with zinc oxide eugenol paste only (Table 4)

4.2 LIPOE frequency

According to the radiographic evaluation of endodontically treated abutment teeth, 59.4% showed LIPOE (Figure 1), which is relatively high considering the potential for successful endodontic treatment. However, compared to previous studies, this frequency remained within the range reported by related cross-sectional studies that used periapical or panoramic radiographs to perform the assessment. According to Gencoglu N *and al* (2010), 73.9% presented with apical periodontitis post-endodontic [2]. Similarly Toliás D *and al* found a rate of 64.9 % (2012) and 39.5% according to Sanaa *and al*. (2011) [22,23]. Unlike other more recent studies, apical periodontitis was found to be relatively common in this sample, Gheorghe AG *and al* found 49.80% (2019)[10], Conert T *and al*, 34% (2018) [21] and 7.7% according to Koutsouri MH (2022)[24]. In view of these different results, it could be that the advent of new technologies as well as innovation in endodontics are among the determining factors in the reduction in endodontic treatment failure rates and the frequency of apical periodontitis in some country. In addition, this discrepancy could also be explained by failure of the initial endodontic treatment, evoking the need to demonstrate compliance with the mechanical and biological imperatives during endodontic treatment.

4.3 Frequency of LIPOE and quality of root canal filling

In this study, inadequate root canal filling was been correlated with a high prevalence of LIPOE (95.6%) (table 6). One of the most common reasons was incomplete root canal fillings in 96.7% of cases and that of the overflowing root canal filling was 93.3% (table 7). Similar results have been reported in previous studies on root fillings with voids and a

porous appearance associated with a high risk of periapical radiolucency (34.6%) [25]. An equally high prevalence of LIPOE has also been reported in other studies, 50% of endodontically treated teeth were classified as having substandard root filling quality [11].

Poor homogeneity was prevalent in 46.2% in Nascimento's study *and al* [26]. Teeth with insufficient root fillings have left a void that will serve as a refuge for bacteria, subsequently colonizing the periapex and inducing the occurrence of LIPOE. Indeed, the present study indicated that the occurrence of apical periodontitis is strongly associated with inadequate root fillings ($p < 0.000$). This correlation corroborates Thomas Conert's study *and al* (2018) [21] who mentioned that root filling quality is a statistically significant factor of the periapical health ($p = 0.01$). The reason could be related to the difficulty encountered in the therapeutic approaches, working length errors, types of filling materials.

These results underline the need to improve the quality of endodontic treatment in order to promote peri-root health.

4.4 LIPOE frequency and prosthetic restoration quality

The quality of the prosthetic restoration represents another factor that has an impact on the periapical health of endodontically treated abutment teeth. Fewer teeth with an adequate restoration (37.4%) showed apical periodontitis than teeth with an inadequate restoration (82%) (Table 6). According to the results, the association between the occurrence of LIPOE and inadequate restorative quality was statistically significant ($p < 0.000$). Other studies have confirmed this relationship; the risk of LIPOE is 2.21 times higher in case of inadequate coronary restoration [9].

In the present study, the clinical condition of the prosthetic restorations was also examined to overcome the limitations of radiographic analysis during the assessment of marginal fit, point of contact and coronary leakage. Ninety-one percent of the abutment teeth with a non-hermetic cervical limit showed LIPOE, with a highly significant difference ($p < 0.000$). This was confirmed by Tronstad *and al* [27], they reported that coronal leakage caused by inadequate restorations was significantly related to endodontic treatment failure subsequently favoring LIPOE. In addition, caries was found on 95, 5% of abutment teeth, with a highly significant difference. Therefore, the presence of a carious lesion has an increased risk of developing apical periodontitis.

In addition to the non-hermetic cervical limit and recurrent caries, various iatrogenic factors during prosthetic procedures have been incriminated to promote LIPOE such as the presence of an overhang on 93.8% of the abutment teeth ($p < 0.000$), the short post on 77.5% of cases whereas post length should be equal to clinical crown length, and at least 3 mm of well-condensed root filling must remain apical to post preparation. Thus, the results of the present study showed that the quality of the prosthetic restoration affects the periapical state of the teeth treated by endodontics. The results were found to be similar to those of other studies [28, 29].

5 Conclusion

The results of this study revealed that the periapical health of endodontically treated teeth depends on both the quality of the final endodontic treatment and the prosthetic restoration. Various iatrogenic factors linked to the occurrence of LIPOE have been elucidated, whether on the prosthetic restoration or on the quality of the canal filling, notably short post, presence of overhang, recurrent caries, non-hermetic cervical limit, insufficient and overflowing canal filling. However, theoretically, adequate endodontic treatment appears to have a positive effect on periapical health than adequate coronal restoration. Nevertheless, practitioners should consider both determinants to improve the overall quality of all restorative treatments to prevent the occurrence of LIPOE.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflicts of interest.

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by any of the authors.

Statement of informed consent

Informed consent was obtained from the patients involved in the study

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